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EDITORIAL

April fourth is the Commencement Day of the University. Graduating student, on that day you put on the cap and gown and receive your degree amidst the cheers of the crowd. In that moment of elation, pride, mingled with joy at the success you have attained after five or six years of hard struggle with the farm, the book, and the professor, reigns supreme in your soul. And in the midst of the excitement of that day you are apt to fail to grasp the broader significance of the event in which you are the chief participant. Perhaps you will be thinking that at last the days of worry are over, the lessons, the work, the experiments and other school duties are ended. Perhaps you will be planning also what to do next. But that is not all. Commencement means more than that. To you it means not only the end of university life but also the beginning of another life, where competition is still keener, and which carries with it more individual independence of thought and action, more individual initiative, and larger responsibilities. It involves also failure or success in what you undertake. To your Alma Mater it means a proclamation to the country that she is through with the tutorship with which the country has entrusted her, and on that day she places you with your technical training and devotion to service and public welfare, at the disposal of the STATE. And to the STATE it means that on that day you automatically become a full-pledged soldier of the army that carries into every nook of her dominion the gospel and standards of modern scientific agriculture that you are ready for WORK.

Agriculture in our country is behind the times. The majority of our farmers are victims of tradition and superstition. As a consequence we do not raise enough food to supply our needs and depend for much of it upon other countries. The quality of our products is often inferior, and there is plenty of room for improvement. Surely "So much to do so little done." Go forward, comrades; awaken the people from their century-old farm ideas and practices; preach seed selection, intensive cultivation and scientific management of the soil; exploit the virgin lands of Minda-

nao, Luzon, and the Visayas. You have a big task before you, but do not shrink. You may fail at the outset, but, if you are the right man, experience is power and the stepping stone to success. Remember the wise counsel of one of your professors that "There is no real failure except in doing less than the best you can." Be a credit, a pride to your Alma Mater! Your predecessors have already given her a name, and it is one of your duties to preserve that name. We most heartily welcome you to the ranks of producers, and we wish you, in whatever field you may engage, whether in private practice, in the employ of other individuals or in the government service, the best of success.—J. J. M.

THE PHILIPPINE AGRICULTURIST AND FORESTER

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Philippine Corn Culture with Special Reference to Source of Seed and Distancing

By Valentin Macasaet, Jr.

Thesis presented for graduation from the College of Agriculture, No. 86.

The Filipino farmers commonly raise their own corn seed. Under the conditions in vogue among these planters who are mostly untrained on scientific methods of seed selection, this practice may result in gradual degeneration.

The present experiment has for its object the testing in culture of corn of the same strain obtained from various places, especially from places having different conditions of soil and climate at different distances from the point of planting, but within the Archipelago. That is, to find out which would be better for a farmer, to produce and select his seed corn under the soil and climatic conditions of his own locality or to obtain his seed corn from a seed-corn grower in a different place where the conditions of soil and climate may or may not be similar to those of his own region. For example, will a good seed corn grown in Mindanao or in any of the Visayan Islands do as well if cultured in Luzon as in the place of its origin?

As an illustration, one specific case of this nature might be cited. The Moro corn when cultivated in the Southern Islands gives very good results. The ears are large with well developed kernels. But the culture of this corn at the College of Agriculture gives a very poor yield. In the first generation almost all the ears are only partially developed.

To accomplish the purpose of this experiment seed corn from different places in the Archipelago was secured. In obtaining this seed care was taken that all was from a similar strain and common stock—none from a pedigree-selected corn.

Seed was obtained from the following places:

Puerto Princesa, Palawan	2	ears.
La Paz, Iloilo	12	"
Dao, Antique	2	"
Calapan, Mindoro	12	"
Pinagtongolan, Lipa	12	"
Luta, Lipa	12	"
Mayondon, Los Baños	12	"
Silang, Cavite	12	"
Masalucot, Candelaria, Tayabas	4	"
Bocaue, Bulacan	12	"
Santo Tomas, Aliaga, N. E.	12	"
Subic, Zambales	6	"

On May 20, 1916, all these seed corns were on hand. After the physical characteristics of the average ears of each sample were taken, each seed sample was divided into two portions and one portion was planted on May 26, 1916. The seeds were planted side by side in one uniform field, so that they were all under the same conditions. For each strain 2 rows were planted. The planting was done after the native method. The distancing was also that used by local farmers. This was done in order to make comparisons with local yields. In cultivating, however, the corn was not ridged as in the native method, but the ground was kept in good tilth with the single-horse cultivator. This continued until the ears were nearly fully developed.

When the corn matured, the average height of the plants and length of the ears were taken. This was done by measuring ten plants picked at random from the different parts of the field and the average of these was taken to represent the average height. When the plants matured and were harvested the total product was weighed. The ears and stalks were weighed separately and the marketable ears, nubbins and culls were each separately weighed. All the marketable ears of each lot were cured

and the production of each was calculated in terms of cavans of cured seeds per hectare, based on the marketable products.

Although belonging to one common variety, the native yellow flint, each corn from a given place may well be considered as a distinct strain on account of its difference from all the others in habit of growth and length of crop period. B. B. 5923 matured in 97 days with an average height of over 3 meters. D. A. 5925, on the other hand, matured in 81 days, or over two weeks ahead of B. B. 5923, and attained an average height of a little over 2 meters or ⅔ that of B. B. 5923. All the other samples show a variation more or less similar. These experiments show that the length of the crop period and the height attained by the plant relate directly to production. B. B. 5923 matured the latest, grew the tallest and yielded the most per hectare. D. A. 5925 and P. L. 5917 matured the earliest, attained a low height and yielded low, only about ½ as much as B. B. 5923.

Thus this experiment shows that a good seed corn must have a sufficiently long crop period, about one hundred days, because a long growth is favorable to good production. It should be also a fairly tall-growing strain, for, as the experiment proved, the heaviest-yielding strains are also the tallest growing.

Some may hold the view that by using the short-growing strains a farmer would be able to make more cultures a year but the almost double yield of the long-growing types will make up for the extra time required to complete maturity. Moreover, with the long-growing types, less expense in a year in the preparation and cultivation of the soil and harvesting crop would be incurred than with the short-growing types and therefore would give a larger margin of profit.

YIELD OF THE MOTHER EARS COMPARED WITH YIELDS OF THE CULTURES AT THE COLLEGE OF AGRICULTURE

In order to see whether or not the seed corn from the various places of the Islands had decreased or increased in its producing power, the yield of the original stock was computed and compared with the yields of the cultures at the College of Agriculture. The results were as follows:

COMPARISONS OF THE YIELD OF THE MOTHER STOCK AND OF THE CULTURE AT THE COLLEGE

C. A. No.	*Source*	*Ave. yield per ear, cured kernels.*		*Ave. yield per Ha. in cavans, cured kernels.*		*Amt. of increase or decrease of production.*	*% of increase or decrease of production.*
		Mother	*Generation I*	*Mother*	*Generation I*		
5916	Calapan, Mindoro.....	119.12g	110.15g	63.54	58.84	–4.70	–7.39
5917	Pinagtongolan, Lipa....	93.18	89.87	49.77	47.15	–2.62	–5.26
5918	Luta, Lipa.....	126.38	124.30	67.51	66.39	–1.22	–1.85
5919	Silang, Cavite.....	97.67	135.60	52.17	70.72	8.55	16.38
5920	Candelaria, Tayabas....	84.46	120.09	45.11	64.15	19.04	42.20
5921	Mayondon, Los Baños..	102.79	128.34	54.91	68.55	13.64	24.84
5922	Aliaga, N. E.....	109.50	135.35	58.49	70.58	12.09	20.67
5923	Bocaue, Bulacan.....	149.46	160.78	79.84	86.22	6.38	7.97
5924	Subic, Zambales.....	115.97	137.19	61.94	72.22	10.28	16.59
5925	Dao, Antique.....	84.55	79.39	45.69	42.38	–3.31	–7.24
5926	La Paz, Iloilo.....	143.30	138.67	76.54	74.11	–2.43	–3.17
6346	Puerto Princesa, Palawan	148.81	92.5	79.52	52.08	–27.44	–34.50

From the table it appears that the average production per ear and per hectare in weight of cured seed of the mothers of C. M. 5916, D. A. 5925, L. F. 5926 and P. P. 6346 was greater than the production per ear and per hectare of the culture at the College of Agriculture. L. L. B. 5918 produced practically the same as the mother and all the others excelled the mother. Examining the source of the seed corns that produced below the average of the mother stock we see that three came from the Southern Islands—Dao, Antique; La Paz, Iloilo; and Puerto Princesa, Palawan,—one from midway— Calapan, Mindoro—and the others from the provinces adjoining and nearby Laguna.

It is evident that the transfer of seed corn from one locality to another is not sound farm economy and it would not be a good practice for a farmer of one locality to obtain his seed corn from a different locality which has entirely different conditions from his own, both as to soil and climate. It would seem a fairly safe assumption that seed corn transported so short a distance as from Lipa to Los Baños, would show no difference in yield when cultured, but actual tests showed that its yield was decreased by about 2 to 5% per hectare. In the case of seed corns from Mindoro the production per hectare was decreased about 7%; from Iloilo 3%; from Antique 7%; and from Palawan the decrease was almost 35%. With seed corns from other sources, however, the average production per hectare was increased.

From the results given above it would seem to be most profitable for a famer to save his own seed corn, or to secure it in his own locality where the variety is already adapted to soil and climatic conditions. It would be of great advantage to the farmers were there an expert seed-corn grower in every agricultural community.

However, for the benefit of local stock it is advisable to secure occasionally fine seed corns from adjoining farms. This often gives good results. Darwin says:

> "It is a common practice with horticulturists to obtain seeds from another place having a very different soil, so as to avoid raising plants for a long succession of generations under the same conditions; but with all the species which freely inter-crossed by the aid of the insects or the wind, it would be an incomparably better plan to obtain seeds of the required variety which had been raised for some generations under as different conditions as possible, and sow them in alternate rows with seeds matured in the old garden. The two stocks would then intercross, with a thorough blending of their organizations, and with no loss of purity to the variety, and this would yield far more favorable results than a mere change of seeds." [1]

THE SECOND CULTURE

The second culture was planted on November 10, 1916, and was harvested on February 21, 1917. The seed used for this culture was the second portion of the original stock and the F^1 generation. The original stock seed, having lost its vitality, did not grow. The experiment was therefore continued with the F^1 generation seed. The same method of procedure of culture and of record as in Culture I was followed.

As in Culture I, we again see the late maturing strains are also the heavy yielders. A N. E. 5992, for instance, matured in 104 days with an average yield of 59.62 cavans of marketable grain per hectare, while P. L. B. 5917 matured in 95 days with an average

[1] Bailey and Gilbert, Plant Breeding (1915), pp. 109-110.

yield of 40.35 cavans per hectare. In time of maturing the difference of the two corns was 8 days and in amount of production it was 19.27 cavans of cured marketable grain per hectare. This gives an increase of over 2 cavans a day for every additional day in maturing period. But these strains were the two extremes. Six strains matured in about 104 days with an average yield of 56 cavans of cured marketable grain per hectare, and 5 matured in only 95 days with an average yield of 43 cavans per hectare, or a difference of 13 cavans in favor of the late-maturing varieties. It is, therefore, very evident that the corn, to give high productivity, should not mature in less than 100 days. A long growing period not only gives the plants a good chance to utilize the most of the plant foods in the soil but also gives then chance to fully develop their ears, and therefore materially increase their production.

The height attained by the plants has also a direct bearing on the production of corn. The six strains that matured in 104 days and produced each 13 cavans per hectare more than the other strains were the tallest. They averaged about two meters while the others averaged only a little over one and one-half meters in height. The tall and big plants have plenty of leaves to manufacture food and therefore are more able to produce good-sized and well-developed ears. Big and tall plants are also better able to support large ears.

DISTANCING AND NUMBER OF PLANTS IN A HILL

Like most other crops in the Islands, corn is usually planted without proper consideration of methods of culture. Some farmers plant corn so close and thick as to make cultivation impossible, and others so far apart as to waste area of ground.

> "A proper number of stalks evenly distributed, so that none will suffer from crowding and so that there will be enough to produce the greatest number of well-formed ears, constitutes the best stand for production of ear corn. If planted thicker than this, the weight of stover increases and the production of good ears decreases. If planted thinner, the weight of stover, as well as of ears, decreases. Small growing varieties should be planted thicker than varieties producing tall stalks."—(U. S. D. A. Farmers' Bull. 414, p. 23).

In the United States many good experiments have been carried out on this subject but results there cannot be closely applied in the Philippines on account of the great differences between the soil and climatic conditions in the two countries as well as between the implements and seed used. It is one object of the present work to find the minimum safe distance and number of plants per hill, under our conditions, that will give reasonable results. In distancing, I made tests of 50 centimeters, 60 centimeters, 80 centimeters, 90 centimeters and 100 centimeters each way. With the number of plants per hill at distances of 25 centimeters in the row and 80 centimeters between rows, 2 plants per hill at distances of 80 centimeters x 80 centimeters, 3 plants and 4 plants per hill at distances of 80 centimeters by 80 centimeters.

The seed used was C. A. 5917 Yellow Flint from Pinagtongolan, Lipa, Batangas. This corn is rather a dwarf variety, averaging 260 centimeters in height, and the conclusions arrived at should be applied only with similarly dwarfed corns.

The ground used was as uniform as possible and in no case were fertilizers used. There were two cultures made, one in the rainy season and one in the dry season. The first, or the rainy-season culture was planted on May 26, 1916, and was harvested on August 13, 1916. All the products were weighed. The results are tabulated below:

CULTURE I

YIELD OF C. A. 5917 YELLOW FLINT AT DIFFERENT DISTANCES OF PLANTING

Distance in cm.		*No. of plants to Ha.*	*Amt. of seeds used in liters to Ha.*	*Total weight Stover Kg.*	*Total weight ears, Kg.*	*Ave. wt. of ears per plant in grams*	*Yield per Ha. in Kg.*	
Rows	*In rows*						*Stover*	*Ears*
50	50	80,000	27	175.6	77.3	118.01	14,744	9440.
60	60	55,554	19	226.7	87.9	146.25	15,862	8124.7
70	70	40,818	14	193.4	73.9	123.37	11,598	5035.7
80	80	31,250	11	156.4	56.7	14.24	8,662	3163.7
90	90	24,716	9	136.7	64.4	1,216.61	6,372	3475.3
100	100	20,000	7	99.6	47.1	126.1	4,223	2525.4

From the table it appears that the average weight of the ears per plant is almost the same for all distances. At 50 cm. x 50 cm. the average weight per plant was 118 grams and at 100 cm. x 100 cm. only 126.27 grams. But when we come to the yield per hectare, both in stover and in ears, the yield gradually decreases as the distance increases. The distance of 50 centimeters x 50 centimeters gave the heaviest yield in ears though in stover it is slightly less than 60 cm. x 60 cm. and the lowest yield both in weight of ears and weight of stover is 100 centimeters x 100 centimeters. Thus it is evident that it is a poor economy to allow more space to a plant than is necessary for the good development of the plant. For this strain of native Yellow Flint corn, 50 centimeters distancing gives the best results.

The second, or the dry season culture, which was planted on November 10, 1916 and harvested on February 10, 1917, shows similar results, as can be seen in the following table:

CULTURE II

YIELD OF C. A. 5917 YELLOW FLINT CORN AT DIFFERENT DISTANCES OF PLANTING

Distance in cm.		*No. of plants to the Ha.*	*Amt. of seeds used in liters per Ha.*	*Total weight stover in Kg.*	*Total weight ears in Kg.*	*Av. weight of kernels Ear Cured Seeds in grams.*	*Yield per Ha.*	
Rows	*In rows*						*Forage in Kg.*	*Shelled Corn in Cavans*
50	50	80,000	27	38.4	19.4	70.89	7,680	32.57
60	60	55,554	19	25.4	14.6	66.00	5,644	30.31
70	70	40,818	14	23.4	15.2	83.36	4,382	23.68
80	80	31,250	11	24.0	15.8	74.55	4,037	21.97
90	90	24,716	9	27.5	14.2	75.75	4,074	20.77
100	100	20,000	7	20.0	12.0	76.09	2,667	13.50

As the figures for the average weight of cured kernels per ear show, there is no gain in size of ears as the plants are set farther apart. On the contrary the yield, both in weight of stover and in cavans of cured grains, decreases as the distance increases. The yield of 50 x 50 cm. distancing is the greatest in both products. These results show that the minimum distance of planting for C. A. 5917 Yellow Flint Corn from Lipa, Batangas, and the like corns, is

about 50 cm. With distances farther apart it is too thin and closer cultivation would be difficult.

NUMBER OF PLANTS IN A HILL

There are differences of opinion among native farmers as to how many plants to grow in a hill. Some allow 2 plants, others 3 plants, and still others 4 plants to the hill. This preliminary work on the number of plants to a hill may throw some light on the subject. Tests were made with planting, 1 kernel in a hill at distances 25 cm. in the rows and 80 cm. between the rows and 2 kernels, 3 kernels and 4 kernels per hill at distances 80 centimeters in the rows and 80 centimeters between rows. The experiment was carried out through two cultures, one during the rainy season and another during the dry season. In both cases the results are in favor of 1 plant per hill at distances 80 cm. x 25 centimeters, and 3 plants per hill at distances 80 centimeters both ways. The figures below show the results:

CULTURE I—RAINY SEASON

YIELD OF C. A. 5917 YELLOW FLINT CORN AT DIFFERENT RATES OF SOWING PER HECTARE

Distance in cm.		*No. of plants to the Ha.*	*Amt. of seeds used per Ha. in liters*	*Total weight stover Kg.*	*Total weight ears Kg.*	*Ave. weight per ear in grams*	*Yield per Ha.*	
Rows	*In rows*						*Forage Kg.*	*Ears Kg.*
80	25	50,000	18	96.6	36.1	141.61	7255	7080.50
80	80	31,250	11	153.9	54.95	141.99	13396	4437.19
80	80	46,875	16	197.4	80.45	138.97	34286	6514.22
80	80	62,500	22	139.6	75.2	102.16	15333	6385.00

These figures show that the greatest results are obtained by putting 1 plant in a hill at distances 80 cm. x 25 centimeters and 3 plants in a hill at distances 80 centimeters x 80 centimeters. The amount of seeds used when we plant 4 plants in a hill at 80 centimeters x 80 centimeters is two liters more per hectare than when we plant only 1 plant per hill at 80 centimeters x 25 centimeters, but the yield of the latter is 695 kilograms of ears more than the former. But the yield in stover of the latter is less than the former. On the other hand, planting only 2 plants in a hill requires 7 liters of seeds less than 1 plant per hill but the yield in ears is 2643 kilograms less. The average weight per ear decreases as the number of plants per hill increases. The average weight per ear when it is planted 2 plants in a hill is about 124 grams, but when 3 plants per hill, it is about 139 grams and when 4 plants per hill, it is only 102 grams.

The second, or dry-season culture, shows equally good results. The one-plant per hill at 80 cm. x 25 cm. produced the heaviest yield in grains and the four-plant per hill the lowest, as can be seen in the following table:

CULTURE II—DRY SEASON

Distance in cm.		*No. of plante to the Ha.*	*Amt. of seeds used per Ha. in liters*	*Total weight stover Kg.*	*Total weight ears Kg.*	*Ave. weight of cured seeds Ear in grams*	*Yield per Ha.*	
Rows	*In rows*						*Stover Kg.*	*Shelled Corn in cavans*
80	25	50,000	18	25.4	17.5	82.85	4,233	29.18
80	80	31,250	11	24.0	13.2	81.70	4,000	21.88
80	80	46,875	16	30.0	15.4	82.12	5,000	23.57
80	80	62,500	22	25.8	13.8	51.67	4,300	13.71

The corn planted at the rate of 1 plant per hill at 80 cm. x 25 cm., 2 plants and 3 plants per hill at 80 cm. x 80 cm. had almost the same average per ear but the total production per hectare of the 2 plants per hill is very much less than the one plant per hill. This is because in the one plant per hill there is a considerably larger number of plants per hectare, so though the ears from both 1 plant and 2 plants per hill are practically the same size, the yield per hectare of the plant per hill is then greater. The 4 plants per hill gave even a less total number of cavans per hectare than 2 plants per hill. In 4 plants per hill the number of plants to the hectare is double that of 2 plants per hill, but the average of cured kernels per ear of the former is very much less than that of the latter and this accounts for its smaller total product in kernels per hectare.

The Agronomy I Class conducted a similar experiment, "correlation, between distance of planting and yield", and they obtained similar results. The corn planted in rows 1.5 millimeters apart with 1 plant at every 20th centimeter gave a total weight of cured kernel of 3755 kilograms per hectare and that planted in rows 1 meter apart and 1 meter in the rows with 3 plants in a hill, 3610 kilograms per hectare.

SUMMARY

1. These experiments showed that the length of the crop periods of the Native Yellow Flint Corn has a direct bearing upon production. The long-season strains were the most productive.

2. The height attained by the plants was also shown to be directly related to the amount of production. The test showed that the taller-growing strains were heavier yielders than were the dwarf ones.

3. The experiments showed that the transporting of seed corn from one locality to another decreases its productive power, at least in the first and second generations. It would, therefore, not be a good practice for a farmer to obtain seed corn from a distant place. A good seed corn would be one that is well adapted to the climatic and soil conditions of the place where it is to be grown.

4. In planting, the minimum distance that gives good results at the same time allowing ample enough space for the most efficient handling and cultivation of C. A. 5917 Yellow Flint Corn and similarly low-growing strains was found to be 50 centimeters each way. Planting thinner than this means a decrease both in total weight of grain and stover, while thicker planting gives a tremendous crop of stover at the expense of ears.

CONCLUSIONS AND RECOMMENDATIONS

1. In the Yellow Flint, the most common Philippine corn, the long-growing strains are the heavy yielders. These mature in about 100 days.

2. The tall-growing strains are more productive than the dwarf types. They attain a height of from 250 centimeters to 300 centimeters or more.

3. The short-growing strains mature in about 90 days and attain a height of from 200 to 250 centimeters. These are not recommended for field culture.

4. Seed corn should be well adapted to the seasonal and soil conditions of the locality where it is to be planted and should be grown in that immediate region.

5. Transporting seed corn from one distant locality to another seems to decrease production.

6. Too thick planting results in an increase in the total weight of stover at the expense of the ears. Too thin planting on the other hand decreases the total weight of both stover and ears.

7. For C. A. 5917 Yellow Flint Corn and similar low-growing strains of the Native Yellow Flint, the planting distance that gives the best results is 50 centimeters x 50 centimeters. With greater distances apart the total weight of stover and ears gradually decreases.

8. Planting C. A. 5917 Yellow Flint and similar low-growing corns in rows 80 centimeters apart with 1 plant at every 25 centimeters gives better yield than when 2 plants are planted to a hill, 3 plants to a hill or 4 plants to a hill at distances 80 centimeters between rows and 80 centimeters in the rows. With 4 plants the total weight of ears per hectare is more than with 2 plants per hill at distance 80 centimeters x 80 centimetrs, but the average weight per ear of the former is very much less than that of the latter.

9. In a country, like the Philippines, where modern agriculture is yet in its infancy, the native farmers cannot be easily taught to grow their own seed corn. Under these conditions for every corn growing there should be a specially trained seed-corn grower from whom well bred seeds could be obtained.

ACKNOWLEDGEMENT

In closing I desire to express my obligations to Prof. C. F. Baker, who helped me in obtaining my seed samples and under whose direction and suggestions the foregoing work has been conducted.

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A Study of Tobacco Worms[1] and Methods of Control

By Leon B. Edrozo

Thesis presented for graduation from the College of Agriculture, No. 87

INTRODUCTION

The extent of the tobacco industry in the Philippines and the wide distribution of the product in the world's markets make tobacco one of the very important money crops of the country. Because of this importance, investigation of questions bearing directly upon the growing of the tobacco plant and the production of leaves desirable for manufacture is necessary from a practical point of view. In most countries where tobacco is grown on a large scale a thorough knowledge of the plant and its enemies is considered essential for the production of leaves of high quality, the only kind that makes the industry yield its paramount profit.

Tobacco growers the world over are familiar with a number of tobacco-worms which by the damage they do to the leaf tend to reduce the profits of the crop. The loss from this cause, which varies greatly from year to year, is due largely to the attacks of such insects while the plants are still in their most active period of growth. Throughout the tobacco regions in the Philippines, little attention has been given to the study of tobacco-worms, though it is considered one of the controlling factors in tobacco raising. The estimated loss from this pest in the Islands runs into hundreds of thousands of pesos annually. In the Cagayan Valley during the tobacco season of 1915-1916, the loss amounted to from 40 to 60% of the possible crop. Much of this loss might be prevented if the producer had been in a position to give the matter some study and use intelligent precautions for control.

[1] A common name given to the larvae or caterpillars of several species of lepidopterous insects injurious to tobacco leaf during the growing period.

The present paper is intended to outline for the practical producer the life histories of the various tobacco-worms and their behavior, and to explain the known measures by which such enemies can be prevented or eradicated. In the present paper four species found on the farm of the College of Agriculture have been used, namely *Prodenia litura*[2] Fabr., *Chloridea assulta* Guen., *Plusia eriosoma* Guen., and *Gnorimoschema heliopa* Trower; and all have been carefully studied in the insectary, as well as in the field.

THE TOBACCO CUT-WORM, PRODENIA LITURA FABR.

Prodenia litura Fabr. is a moth belonging to the family Noctuidae. The adult is characterized by having semi-erect tufts of scales on the metanotum. The fore legs are smoothly scaled. The head is yellowish brown, fore wings with some ochreous streaks at the base and suffused with pale brown; about one-third the distance from the base on the anal margin are two heavy white patches, sloping obliquely backward but not reaching the costal margin; these are cut transversely by two white patches running from the basal portion down to about the middle of the wing; there is still another white patch from the base almost parallel with the costal margin of the wing; black streaks occupy the greater part of the wing, especially near the tip; ciliae black

[2] Hampson Cat. Lep. Phal. B.M. (1909) 8:245. Note: The species treated in this thesis is undoubtedly *P. litura* F. described for many years as *P. littoralis* and incorrectly identified in America as *P. ornithogalli* Guen., a species confined to the western hemisphere and which, while closely allied, has nothing to do with the old world *litura* spreading eastward from Egypt to the Philippines and southward to Australia, through Borneo, New Guinea and most of the Islands of the Indo-Australian region. [C. S. Banks].

with pale streaks through them. The hind wing is opalescent white with a dark marginal line, which is most distinct at the tip; the veins are pale brownish yellow, darker and heavier at tip. Abdomen is darker brown above than below; spiracles black, five in number on each side; the proboscis and antennae are long and dark brown.

DISTRIBUTION

According to Swinhoe[1] *Prodenia litura* Fabr., called *Prodenia littoralis* by Boisduval, occurs throughout the Oriental as well as well as southern Pallarctic region and in the Philippines. Hampson[2] gives the Mediterranean sub-region and the eastern tropics as its range. In India, *Prodenia litura* is recorded from the Himalayas and Tigris and has been reared by all entomologists connected with the Department of Agriculture.

EXTENT OF INJURY

In the school year 1913 and 1914 larvae of this moth appeared on tobacco plants but rarely at the College of Agriculture. They were noted feeding on tobacco and cabbage. In 1914 and 1915, during the period of greatest growth of the crop, they were noted in large numbers in the tobacco plantation of one of the students, where they were observed to be very destructive. The fields used had been previously planted with cabbages that were infected with great numbers of larvae. During that year (1914-1915), besides being on tobacco and cabbage, they were noted feeding on castor oil plants, peanuts, lettuce, and celery. As the larvae pupate in the ground, it is reasonable to suppose that such places are thoroughly infested with the pest and that later crop plants then will be liable to attacks in force. For this reason, fields planted with crops infected with larvae should not be planted with tobacco the following year.

The caterpillar, when young, eats the soft epidermal tissues of the leaf but when full grown it becomes voracious, eating the whole tissue of the leaf. Leaves newly poled are also attacked and great destruction may occur in the curing shed. The caterpillar begins eating along the midribs and then proceeds gradually toward the margins until none of the blade of the leaf remains. Knowing this behavior of the insect, every *veguero*[3] should instruct laborers to look sharply for worms on both surfaces of the leaves at the time that poling is done. Eggs must also be looked for, otherwise they will soon hatch, and trouble will result.

The life cycle of this moth requires about a month for completion.

LIFE HISTORY

Eggs.—The female lays eggs in masses on both surfaces of the leaves. Each egg is covered with a brown or buff colored mass of hair-like scales from the anal tuff of the moth. Eggs are arranged in close rows. They are pale green, almost spherical, being flattened beneath and seen from above are radially ridged. Viewed from the side, ridges can be noted, the depressions between which are very shallow. Transverse stripes are also noted with narrower spaces between. The diameter of the egg is .5 mm. Counts of eggs show from 104 to 433, the majority of batches containing 200 to 300. A single moth has been found to lay 433 eggs.

Eggs laid 1st night 261
Eggs laid 2nd night 172
433
Number of mature eggs found in one female when dissected, 274.

[1] Catalogue of Eastern Lepidoptera Heterocera (1900) 2: 32.

[2] Fauna of British India, Moths (1894) 2:247.

[3] Spanish term in common use to designate one who harvests and poles tobacco leaf.

On the third day after laying the eggs hatch.

First instar.—The newly hatched larva is about 1.5 mm. long. It has four pairs of abdominal legs situated on the third to the sixth segments respectively. It has a semi-looper's gait when walking. Larvae after hatching remain in company at the place where they hatch and feed on the soft tissue of the leaf. As they eat they spread apart a little and after a few days, scatter over the leaf surface. The most striking feature of the young larvae is the dark band crossing the first abdominal segment; this characteristic is of great value in identifying the caterpillars of *Prodenia litura.*

Second instar.—After four days the first molt takes place. The length increases to 3.5 mm. Head, amber yellow, with black scattered spots. Thorax, dull yellowish green. At this time there appears an indistinct central longitudinal line of orange or yellow extending from the head to the anal segment. On each side of the dorso-median line is a dark band composed of grey or black and stippled with white; beyond this band appears another line of orange or yellow; below the latter appears a heavy, dark band stippled with white; this last dark band has a downward curve in each segment and meets the lighter coloring of the venter. The light coloring above varies from orange to yellow. The lower surface is dull grey-green. In this stage the larvae move about but little.

Third instar.—Three days later, the second molt takes place and the length has increased to 7 mm. Now, the markings are quite distinct and in addition to the ones before mentioned, there appear, on each segment toward the sides, black spots, and on the second and third segments counting from the last segment there also appears one black spot on each segment. The abdominal legs and anal legs are dark, greenish yellow, while the true legs are black, except the pair on the prothorax, which is greenish yellow.

Fourth instar.—The third molt takes place three days after the second and the larva increases to a length of 16.5 mm. The coloring develops more or less completely. In habit the larva is now very active, moving freely and feeding on the whole tissue of the leaves. It is to be noted that the larva is most active in feeding at night.

Fifth instar.—The fourth molt takes place three days after the third molt and the larva attains a length of 29.5 mm. It is now very soft and fat, the thorax begins to taper toward the head, the abdominal segments become thick-set and more indistinctly marked.

Sixth instar.—Two days after the fourth molt, the fifth molt takes place and the larva has now attained its full length of 35.5 mm. The thorax becomes still more tapering than in the fifth instar. The markings are well developed and distinct except that the black transversal band on the first abdominal segment fades, leaving only a slight trace. Above, and in line with these traces and on the meso and metathorax, yellow spots are now recognizable. The full-grown larva eats voraciously. In rare instances some of the larger larvae are cannibals, eating the smaller ones. After four days of rapid feeding the larva seeks a place for pupation. It pushes the soil aside and slowly burrows to a depth of from four to five centimeters. It then compacts the soil particles about itself, making an earthen case in which to pupate.

PUPA

Average length of pupa 16.5 mm.; color when fully formed darker brown; surface shiny; head smooth and rounded; eyes black and prominent; wing sheaths

darker than the rest of the body; spiracles as in the pupa of *Chloridea assulta;* abdomen with three movable segments; the first two segments of the abdomen are closer and more distinctly marked than the others; the last segment is peculiarly formed, its tip is prolonged at each side into a short, stout tooth directed forward and slightly separated at tip.

The following table shows the life history of a brood of *Prodenia litura.*

23-IV-1916	Copulation.
26-IV-1916	Eggs laid.
29-IV-1916	Eggs hatched.
3- V-1916	First molt.
6- V-1916	Second molt.
9- V-1916	Third molt.
12- V-1916	Fourth molt.
14- V-1916	Fifth molt.
18- V-1916	Pupated.
29- V-1916	Adults emerged

37 days, length of cycle.

Sixteen newly hatched larvae were enclosed in a jar. These were secured from the previous experiment.

3- V-1916	First molt.
7- V-1916	Second molt.
10- V-1916	Third molt.
12- V-1916	Fourth molt.
15- V-1916	Fifth molt.
19 to 21- V-1916	Pupated.
29- V-1916	Emergence began.
2-VI-1916	Emergence completed

37

A third brood.

25-VI -1916	Copulation.
26-VI -1916	Eggs laid.
29-VI -1916	Eggs hatched.
4-VII-1916	First molt.
8-VII-1916	Second molt.
12-VII-1916	Third molt.
14-VII-1916	Fourth molt.
16-VII-1916	Fifth molt.
18 to 20-VII-1916	Pupation.
29 to 31-VII-1916	Emergence completed

33

A fourth brood.

29-VII -1916	Copulation.
30-VII -1916	Eggs laid.
2-VIII-1916	Eggs hatched.
5-VIII-1916	First molt.
9-VIII-1916	Second molt.
12-VIII-1916	Third molt.
14-VIII-1916	Fourth molt.
16-VIII-1916	Fifth molt.
17 to 20-VIII-1916	Pupation completed.
25 to 29-VIII-1916	Emergence completed

32

A fifth brood.

12- X-1916	Copulation.
13- X-16	Eggs laid.
17- X-16	Eggs hatched.
21- X-16	First molt.
24- X-16	Second molt.
28- X-16	Third molt.
31- X-16	Fourth molt.
2 to 3-XI-16	Fifth molt.
8-XI-16	Pupation.
19 to 22-XI-16	Emergence completed

From the foregoing tables it can be deduced that the life-cycle of *Prodenia litura* varies from 32 to 39 days. Larvae of this insect were found feeding on tobacco seedlings about the second week of October, 1916. The life history does not vary much from one season to another, although it is believed, that *Prodenia* remains longer in the pupal stage during the wet season.

Food plants recorded in the Philippines by Charles R. Jones.

Tomato; attacking both the leaves and fruit.

Tobacco; feeding upon the leaves.

Calaboa (*Monochoria hastata;*) feeding on the leaves.

Maize; feeding upon the leaves of small plants.

Cabbage; feeding upon the leaves.

Rice; eating the leaves.

Sweet potato; feeding upon the leaves.

Castor (*Ricinus communis*); feeding upon the leaves.

Jimson-weed (*Datura* sp.); feeding upon the leaves.

Food Plants recorded for India by H. Maxwell Lefroy,[1] Memoirs of the Dept. of Agriculture, (1908), 2:79-93, p 1. 1.

Lucerne (*Medicago sativa*), abundant on irrigated lands.

Jute (*Corchorus capsularis* and *C. olitorius*), feeds upon the succulent apical shoots.

Indigo; noted in August but not especially serious.

Potato; cutting off young plants.

[1] Phil. Agr. Review, Vol. VI, Sept. 1913, No.
[2] Dept. Agr. India, etc.

Mulberry (*Morus alba*), eating the leaves.

Pakur (*Ficus infectoria*), eats the leaves.

Marua (*Eleusine coracana*), scarce.

Groundnut (*Arachis hypogaea*), feeds upon the leaves.

Urid (*Phaseolus radiatus*), occasionally.

Tur (*Cajanus indicus*), feeds on leaves and pods.

Sugar cane (*Saccharum officininarum*), feeds on the leaves.

Agathy (*Sesbania aegyptiaca*), feeds on the leaves.

Coleus, occasionally in gardens.

Dhaincha (*Sesbania aculeata*), feeds on the leaves.

From the Philippine Agricultural Review, Charles R. Jones, (1913) **6**: No. 9.

Synonymy of *Prodenia ornithogalli*, Fabr., Hamps., Catalogue of Lepidoptera, Phalaenae in B. M. (1909), **8**:245.

Noctua litura Fabr., Syst. Ent. (1775), 601.

Noctua histrionica Fabr., Syst. Ent. (1775), 612.

Noctua elata Fabr., Spec. Ins.(1781), 220.

Hadena littoralis Boisd., Fauna Ent. Madagas. (1833), 91 pl. 13, Fig. 8; Moore.

Hadena retina Frr. Neue Beitr. (1846), **5**, 161, pl. 474, Figs. 2-3; Herr.-Schaff., Eur. Schmett., Noct., figs 144-145.

Prodenia tasmanica Guen., Noct., (1852), **I**, 163.

Prodenia ciligera Guen., Noct. (1852), **I**, 164.

Prodenia testaceoides Guen., Noct. (1852), **I**, 165.

Prodenia subterminalis Wlk. (1856), **9**, 10.

Prodenia galucistriga Wlk. (1856), **9**, 197.

Prodenia declinata Wlk., (1857), **11**, 723.

Mamestra albisparsa Wlk., Journ, Linn Soc., Zool. (1862), **6**, 186.

Prodenia evanescens Butl., Mem. Nat. Ac. Sci. Wash. Rep. Eclipse Exp. (1884,) 94.

Prodenia litura Fabr. (Hamps)., Cat. Lep. Phalaenae (1909), **8**, 245.

CHLORIDEA ASSULTA GUEN

Another species found attacking tobacco on the college farm is *Chloridea assulta*. According to U. S. Department of Agriculture, Farmers' Bulletin No. 120, the species is called the false bud worm, when it attacks tobacco; when it occurs on cotton, it is called the "cotton boll worm"; on tomato, the "tomato fruit worm"; and on corn the "corn ear worm". Throughout the tobacco regions of the Philippine Islands *Chloridea* is very common and it seems to occur during the entire growth period of the crop, although it did not appear on college farm during the months of August and September, 1915. During the present tobacco season of 1916 the first appearance of larvae was observed and recorded on 16 October.

The female lays eggs singly on either surface of the leaf and the larvae do serious damage by feeding on the young leaves. The large larva has the habit of boring into the seed pods destroying the seeds and very often it bores into the flower. This was observed during April and May, 1916. In color and markings the larvae are variable. On tobacco, Howard (U. S. Department of Agriculture, Farmers' Bulletin No. 120) says that there are specimens of a uniform light green without spots or stripes and there are others the general effect of which is nearly black. This is true, when the spiracles are not considered. Between these two extremes many variations occur. The adults when compared are exactly alike or with scarcely describable differences.

DESCRIPTION OF THE ADULT

From Hampson's Catalogue of the Lepidoptera Phalaenae, Vol. 4, p. 47.

"Head and thorax orange tinged with red-brown; fore tibiae brown above; abdomen orange. Forewing orange tinged with red brown; the veins rufous; a double curved subbasal line from costa to submedian fold; the antemedial line double, strongly waved, the inner line indistinct; orbicular and reniform with dark centres and brown outline, the former round; the median line oblique from costa to median nervure, where it is angled, then incurved; the postmedial line double, bent outwards below costa, slightly incurved at discal fold, incurved below vein 4, and with its inner line minutely waved and slightly angled outwards at vein 1, the area beyond it brownish to the subterminal line, which is angled outwards at vein 7, dentate inwards to the postmedial line at vein 5 and outwards nearly to termen on veins 4, 3, 2; cilia rufous. Hindwing orange-yellow; the terminal area broadly black with somewhat sinuous inner edge, with postmedial line just before it between veins 6 and 2. Underside of forewing with the orbicular and reniform black; both wings with blackish band beyond the postmedial line, except on inner area of fore wing and costal area of hind wing."

EGG

Diameter .45 mm., ovoid, pale green. Ridges twenty-four in number running longitudinally; depressions between these ridges, shallow. The base is flat and the tip smooth. Eggs are deposited singly and scattered on both surfaces of the leaf.

LIFE HISTORY

The work was started on full-grown larvae collected from the field.

4-IV-1916...Collected full grown larvae (13 in number).
9 to 11-IV-1916...Pupated.
18-IV-1916...One adult emerged.
20-IV-1916...Four adults emerged.
21-IV-1916...4 adults emerged.
23-IV-1916...4 adults emerged.

From the previous brood a male and a female were used for copulation.

20-IV-1916...Copulated.
22-IV-1916...Eggs laid (75) 1st night.
23-IV-1916...Eggs laid (168) 2nd night.
24-IV-1916...Eggs laid (150) 3rd night.
25-IV-1916...First-laid eggs hatched (Others followed closely.)
29-IV-1916...1st molt.
3- V-1916...2nd molt.
6- V-1916...3rd molt.
10- V-1916...4th molt.
14- V-1916...Pupated.
28- V-1916...Emergence of adult.

LARVA

First instar.—Length of the newly hatched larvae about 2 mm. Color pale, greenish brown; head, black; thorax, pale green. Abdominal segments, pale yellowish green; eyes black, tips of mandibles, dark brown. Abdomen on dorsum hairy—each hair situated on a black spot. Prolegs four pairs situated from the 3rd to the sixth segments respectively. Hairs black but short. Abdominal legs, short, pale whitish green.

Second instar.—The first molt takes place four days after hatching. Length increases to 5 mm. Color, dark greenish brown on the body. Head, pale yellowish brown. Each segment of the thorax has 12 spots (black), 6 being on each side; on each spot grows one black short hair. These spots are arranged in a triangle towards the sides, the lower two being lighter than the four above. These spots are also found on each segment of the abdomen.

Third instar.—The second molt takes place four days after the first and the larva increases to 12 mm. in length. Color, dark brown. Head, amber or citron yellow. First pair of legs very short, light greenish brown; the last two pairs, black. Abdominal prolegs, black; anal pair, green. Tips of labrum, black. In this stage the larva is active, traveling and feeding to a wide extent on the leaf surface.

Fourth instar.—The third skin is cast off three days after the second molt and the larva increases to 15 mm. in

length. The color and markings are now well developed. The only change is that the abdominal prolegs become green.

Fifth instar.—The fourth molt takes place four days after the third and the larva has now attained a length of 21 mm. The thoracic legs become green, only the femur and tibiae remaining black. After two days more, the larva seeks a place for pupation. It pushes the soil particles aside and goes gradually in the soil to a depth of 5 cm. Sometimes the pupa remains just below the surface of the soil.

PUPA

Average length 17.7 mm.; dark brown. Body slender or moderately tapering toward the anal end; surface shiny; bead smooth and rounded; eyes black but not so prominent as in *Prodenia;* wing sheaths, shiny greenish brown; abdomen with four movable segments. The first four abdominal segments are shorter than the remaining segments and the circular depressions at the articulations of segments 1 to 4 are lighter. Segments 5-7 are quite coarsely granulated. The last abdominal segment is polished and very slightly granulated; it is smoothly rounded and prolonged with two black but short cremasters directed backward. Spiracles 7 on each side, dark at the center but very slightly marked. The pupa of *Chloridea* can be distinguished from the pupa of *Prodenia* by its color and slenderer contour.

The following tables show life history records of this insect:

20-IV-1916	Copulation.
22-IV-1916	Eggs laid.
25-IV-1916	Eggs hatched.
28-IV-1916	1st molt.
1- V-1916	2nd molt.
3- V-1916	3rd molt.
6- V-1916	4th molt.
11- V-1916	Pupated.
25- V-1916	Adult emerged.

15-VI-1916	Copulation.
16-VI-1916	Eggs laid.
19-VI-1916	Eggs hatched.
22-VI-1916	1st molt.
26-VI-1916	2nd molt.
1-VII-1916	3rd molt.
4-VII-1916	4th molt.
16-VII-1916	Pupated.
19 to 21-VII-1916	Adults emerged.

10-XI-1916	Copulation
12-XI-1916	Eggs laid.
15-XI-1916	Eggs hatched.
19-XI-1916	1st molt.
22-XI-1916	2nd molt.
26-XI-1916	3rd molt.
29-XI-1916	4th molt.
4 to 5-XII-1916	Pupated.
18 to 21-XII-1916	Adults emerged.

From the above tables it may be seen that the life cycle of *Chloridea assulta* varies from 34-39 days; 36 days being the average. It was recorded that the the last occurrence of full-grown larvae of this insect on the college grounds, was 11 August, 1916, and on 16 October, 1916 young larvae appeared on tobacco seedlings. From this fact, it is believed, that *Chloridea* transfers to other hosts or delays its life cycle while in the adult or pupa. Whatever the truth may be as to this, taking 36 days as the period of one generation, there are then possible ten broods in a year.

The Catalogue of Lepidoptera Phalaenae, Vol. 4, p. 47, gives the habitats of *Chloridea* assulta as follows:

W. Africa, Congo; Japan, Yokohama; Korea, Gensan; E. China, Shanghai. Ichang; Formosa; N. W. Himalayas, Kulu, Sultanpur S. Allahabad; Bhutan; Bombay; Ceylon; Burma, Hsipaw; Java; Queensland, Rockhampton; Samoa; Tahiti. Food Plant: *Physalis peruviana.*

THE TOBACCO STEM BORER

GNORIMOSCHEMA HELIOPA TROWER

Gnorimoschema heliopa is the third and smallest moth of the species so far studied. Besides being found on tobacco, it was also taken on small grasses and

on thick bushes, where it was evidently hiding. The moth was observed to lay eggs on the surface of the stem on tobacco. The newly hatched larva punctures and then gradually works downward or upward inside of the stem. The puncture when newly made is very hard to detect; but after a few days it can be recognized by the rim of the hole being réd. The opening is very carefully closed up with silky white thread which is used as a protection against the entrance of possible enemies. When the larva has been inside for several days a swelling of the stem begins. The presence of larvae can be detected by the punctures, by swelling of the stem, and by the wilting of the young buds. When the last two signs are recognized in the field, plants or sprouts affected should be removed immediately so that the multiplication of the pest can be prevented. The removing of every plant or sprout affected means a saving to the grower.

ADULT MOTH

The head, thorax, and forewings are grey, suffused with purple brown. Abdomen grey, white predominating. Eyes, black and prominent; antennae, 4-5 mm. long. Hind wings are similarly colored but very much lighter, ciliae long and white, suffused with very light orange yellow. The wing expanse of the specimens varies from 12 to 14.5 mm.

EGG

The egg is bean-shaped, and translucent white. The surface not strongly marked with radiating ribs. Cross striae are not distinct. The diameter of the egg is .4 mm. It rests singly on the surface of the stem among the trichemes. Just before hatching the egg turns a pale yellow.

DESCRIPTION OF THE STAGES OF THE LARVA

First instar.—The newly hatched larva is greenish white, very transparent. Head, black and shiny; eyes, black and marked. Tips of mandibles brown, antennae very short. On the prothoracic dorsum is a black band, lighter than the head. Light ground pigments are recognized on the dorsal surface of the abdomen. The legs are very short and are pale greenish yellow. There are four abdominal legs situated on the third to the sixth segments respectively. The anal pair of legs is pale yellowish green. The length of the larva is .9 mm.

2nd and 3rd instars.—The second and third instars are almost identical. The most striking change is the increase in size of the body. In the second instar, the larva attains a length of 4 mm. and in the third instar, 7 mm. The body becomes much larger, more cylindrical in form although it tapers a little toward the extremity. The second and third instars agree in there being dusty pigments scattered over the body. They also agree in having dark brown thoracic legs (from the femoral region to the tip of the claws). In these stages the larvae are very active, feeding on the soft internal tissues of the stem.

4th instar.—The last molt is made 5 days after the second molt; the larva reaches its full length of 10.5 mm., and the whole appearance is slightly changed. The color is pale yellowish white. Head flattened, dark brown; eyes black; labrum, brown. Tip of thoracic legs dark brown; abdominal legs and anal pair same as before. After four days of constant feeding, the larva pupates inside the stem. It covers itself with a silky white mass of threads, a roughly formed cocoon.

PUPA

The length of the pupa is 6 mm. Color, shiny brown, wing cases, opaque. Eyes black and polished but not prominent. Legs reaching the tip of wing-cases. The circular depression on the abdominal segments 1 to 5 are slightly elevated in the middle; segments 6-8 are larger and their margins are strongly elevated and granulated. The last segment is polished and slightly elevated, its tip is broad, rounded and prolonged, on each side, with one stout short cremaster. Spiracles, seven on each side; color, polished dark brown.

The larvae of *Gnorimoschema heliopa* spend their entire lives inside of the stem. Due to this feeding habit, observations on all larval stages were difficult, and throughout the whole course of study, only one determination in each stage, as shown, below in a tabular form, was made. All other notes were made as from copulation to egg-laying, from laying to hatching, from hatching to pupation, and from pupation to emergence. The records show that average length of the life cycle of *Gnorimoschema heliopa* is 32 days.

4-I -1917.....Copulation.
6-I -1917.....Eggs laid.
9-I -1917.....Eggs hatched.
14-I -1917.....1st molt.
17-I -1917.....2nd molt.
22-I -1917.....3rd molt.
26 to 27-I -1917.....Pupated.
9 to 10-II-1917.....Emergence of adults completed.

Remedy:

Gnorimoschema heliopa is the most difficult tobacco pest to control for the reason that the larva works inside of the stem. Paris green used in a spray will not prevent the moth laying eggs on the stem. The best and most practical way of control is to pull up and destroy the plants which are infested with the pest. This lessens the number of larvae and consequently there follows a reduction of the moth. Records of observation made in the field of plants infested follows:

TABLE SHOWING THAT YOUNG PLANTS AND SPROUTS ARE SUSCEPTIBLE TO THIS INSECT

Date of observation	Field I No. of Plants	Field II No. of Plants	Field III No. of Plants
Dec. 8, 1916	8		
Dec. 12, 1916			40
Dec. 13, 1916	43	10	
Dec. 16, 1916	11		
Dec. 21, 1916		4	
Jan. 5, 1917	9	2	
Jan. 13, 1917			21
Jan. 17, 1917			2
Jan. 21, 1917			2
Jan. 23, 1917	2		
Jan. 31, 1917	2		
Feb. 10, 1917	10 sprouts affected		
Feb. 15, 1917			34 sprouts affected.

Plants that are vigorous, healthy, and promising and infested with the pest, should be operated upon for the removal of the larvae. A longitudinal cut should be made on the swollen part of the stem with a clean, sharp, thin bladed knife. Open the cut and with the naked eye the worms may be located. When the exact location is determined, then proceed to kill the worms with the end of the knife. No further treatment should be given to the plant after operation.

Seedlings are attacked very severely, especially those that have been kept for a long time in the seed-flats. A letter to Professor Baker from Mr. Manos, in charge of the Tobacco Experiment Station in Cagayan and Isabela, states that this stem borer does great damage to tobacco seedlings when kept long in the seed-beds. It attacks not only the young plants but also the sprouts. In fact this insect appears most abundantly on the suckers.

Because of this habit of *Gnorimoschema heliopa* it is, therefore, important to transplant the seedlings when they are about from 14 to 16 cm. high. In this way the plants are given wider space and the probability is that they will gain their normal growth very rapidly so that even if they are subjected to the pest later there will be no serious effect because the stem borer can not kill a plant that is already large. Another important thing to do is to remove all sprouts growing at the base of the plant and on the axils of the leaves. This tends to reduce the damage of the pest to a minimum.

PLUSIA ERIOSOMA GUEN.—HISTORY

In the College of Agriculture larvae of *Plusia eriosoma* were first observed feeding on tobacco by Professor Charles S. Banks in 1914. In the year 1916 the first appearance of larvae on tobacco seedlings was recorded on October 25th. While the plants were still in the seedflats, larvae occurred in great numbers and injured the young seedlings greatly. However, when the plants were transplanted to the field and had reached their flowering stage very few of these worms appeared. From the first week of December, 1916 till the 25th of February, 1917, larvae were found in great numbers on carrots, cress, and on celery.

According to Hampson, Fauna of British India, Moths (1894) **2**; p. 569, *Plusia eriosoma* occurs in North and South America; Wadelai; Aden; Japan; China; throughout the Indian, Malayan, and Australasian regions and in the Philippines. It is stated that the food plant is *Ficus*.

MOTH

The forewings of the moth are reddish. Some specimens are darker than others. Head and thorax are similarly colored. Abdomen, with lateral and dorsal tufts. The hind wings are similar in color to forewings but lighter and the veins are also equally prominent On each fore wing, near the center, there are two silvery spots well marked and separated. The anal margins of the fore wings have strongly defined triangular projections.

EGG

The moth lays eggs on both surfaces of the leaf. The eggs are translucent green and quite similar in color to the upper surface of the leaf. They are hemispherical. The average height is .4 mm. and the diameter is .5 mm. The sides are marked with radiating ribs, 37 in number and with transverse striae. Eggs when about to hatch change their color from green to pale yellow. A female was found to have laid 164 eggs.

DESCRIPTION OF THE STAGES OF THE LARVA

First instar.—The newly hatched larva has a length of 1.2 mm. Head high; mouth projecting, antennae short. The body of the larva is slender, somewhat moniliform, and smooth. The general appearance of the body is pale yellowish white. Thoracic legs slightly blackish. Abdominal legs of two pairs, situated on the fifth and sixth segments. The anal pair of legs is pale green. Tubercles small, round, and not very distinct.

2nd instar.—Three days after hatching the first molt takes place and the larva increases to 6.5 mm. in length. The color of the body is pale green. Head, higher than in the first instar, mouth broad and projecting. Body slender, slightly tapering toward the head. Legs pale green. At this stage the larva becomes active, feeding on the leaf.

3rd instar.—The second molt takes place four days after the first and the larva attains a length of 12 mm. Head flattened. The body humped up a little in the legless abdominal segments and

the last abdominal segment enlarged. Legs pale yellowish green. Antennae slightly brown. Spiracles white, 9 on each side.

4th instar.—The third molt takes place two days after the second and the larva increases to 17 mm. in length. Head still high, color as before. The body becomes more tapering, the legless abdominal segments more humped than before. Hairs on the body short and slender. In this instar the larva is very active. It loops rapidly in its crawling and transfers readily from one leaf to another.

5th instar.—The fourth molt occurs 5 days after the third and the larva is then 24 mm. in length. Head becomes more rounded and flattened. Ocelli black or dark brown. Body moderately tapering, the caudal four abdominal segments smoothly and distinctly enlarged.

6th instar. Length 29 mm. In this instar there is a long elliptical spot on each side of the head. The dorsal surface of the body is marked with white undulating lines. The lateral stripe of the abdomen is rather broad and pale yellow. After three days of rapid feeding the larva searches for a place for pupation. It constructs for pupation a fine silky white cocoon, attached to the surface of the leaf, preferably the lower surface.

PUPA

The average length of the pupa is 13.5 mm. The color of the thoracic region and the abdominal dorsum is pale green while the lower surface of the abdomen is whitish brown. Head prominent and stout, eyes prominent. wingsheaths opaque. Metathoracic legs reach the tip of the wingsheaths, but the others do not. Segmental lines on the lower surface of the abdomen are double and heavily marked. Abdomen, prolonged with two dark brown cremasters, used for attachment of the pupa to the cocoon. Around these cremasters are also very short, slender, and hook-shaped spines. The pupa when fully developed turns to light brown.

The following tables show the life history of *Plusia eriosoma:*

25-X -1916. . . .Full-grown larvae collected.
30 to 31-X -1916. . . .Pupated.
9 to 11-XI-1916. . . .Emergence completed.

Adults newly emerged were used for another brood.

10- XI-1916. . . . . .Copulation.
13- XI-1916. . . . . .Eggs laid (164).
16- XI-1916. . . . . .Eggs hatched.
19- XI-1916. . . . . .1st molt.
23- XI-1916. . . . . .2nd molt.
25- XI-1916. . . . . .3rd molt.
30- XI-1916. . . . . .4th molt.
4-XII-1916. . . . . .5th molt.
6 to 7-XII-1916. . . . . .Pupated.
11 to 16-XII-1916. . . . . .Emergence completed.

GENERAL BIBLIOGRAPHY FOR PLUSIA ERIOSOMA

1. Doubl: Dieffenbach's New Zealand, (1843); 285.
2. Walker: (1875) **12:** 933.
3. Hampson: (part) Faun. Brit. Ind., Moths, (1894) **2;** 569.
4. Butler; Entom., (1894) **27;** 214.
5. Hampson: P. Z. S., Lond., (1896) 265.

TOBACCO HORN-WORM
ACHERONTIA LACHESIS FABRICIUS

A sphinx larva was observed on January 24, 1917, feeding on tobacco on the college farm. The general color of the larva is green. Head almost round or flattened, paler greenish yellow than the remainder of the body; mandibles dark yellowish brown. Legs greenish yellow, abdominal legs, four pairs and situated on the third, fourth, and sixth segments. The length of the young larva when collected was 23 mm. with a horn 14 mm. long.

The full-grown larva changed to greenish yellow. Head broad and flat;

mandibles black. Thorax yellowish green with yellow granules. The full-grown larva had 6 lateral oblique stripes, seven on each side of the body; their color when not fully developed, greenish white but when fully developed, bluish yellow. These stripes extend up on the dorsum. Thoracic legs entirely black, while abdominal legs and anal pair are greenish yellow. Spiracles, 8 in number on each side, black at the center. The length of the full-grown larva was 72 mm.

The larva entered the soil to pupate but it is to be regretted that when it was about to transform to a pupa, it died, probably from the attack of some disease. The body became entirely black and half of it decayed giving out a very disagreeable odor.

The actual damage by this sphinx larva on tobacco is probably not serious anywhere in the Islands. In fact only one was found on the college farm during the tobacco season. This is not saying that it may not under certain conditions became a serious pest to tobacco, so it is always advisable to destroy it wherever found.[1]

CONTROL OF PRODENIA AND CHLORIDEA

PARIS GREEN

1. In liquid form.—Spraying experiments were tried of tobacco on the college farm. The formula used was 1 lb. of Paris green, with the combination of an excess of lime to 100 gallons of water. The lime was slaked, made into a paste with the poison, and a small amount of water, then both were strained into the specified volume of water.

The first spraying should be done two or three weeks after the plants have been transplanted. Then after the first application there should be an interval of about ten days, the length of time depending, of course, upon the condition of the plants. Application should be made after rain or at any time during the day when there are no drops of water resting on the surface of the leaves. Late in the afternoon is recommended as the best time. In spraying, care should be taken that the solution settles slowly on the surface of the leaf in the form of a mist. A foot-pump or knapsack spray is the best kind to use. Paris green does not remain in suspension very long so that the solution should be stirred while being applied.

2. In dry form.—The formula used for Paris green in powder form should be 1 part of the poison to 50 parts of lime (stone lime). Mix these two ingredients thoroughly and let the mixture stand for several days before using it. The combination can be dusted on infested plants, either through a sack or cloth of open mash or with a powder gun.

There were two sets of trials made on the college farm and both experiments (wet and dry) were carried out, side by by side. The results proved quite satisfactory, although in the case of liquid, there was observed a slight burning effect on the leaves. This is due to the accumulation of the poison on certain parts of the leaves. This can be remedied by stirring the solution when applying.

The plants used in Field No. 1 were large and through negligence on the part of the owner, the plants were severely attacked by cut-worms. When they were treated with the poison, the work of the larvae was checked in a measure. One day after applying the poison it was observed that six larvae died of the poison. However, many were found still feeding quite contentedly in their usual manner on the lower surfaces of the leaves. This shows that the spray or dust must be applied also to the lower surface of the leaves.

[1] I have observed the larvae of this insect feeding on the leaves of *Sesamum indicum* in 1917. The damage done, however, was not very serious.—[Editor.]

In Field I there were only three applications made, for the plants treated were large, about 1½ feet high while in Field II six applications were necessary. The grower should decide when the last application is to be made. It is not economical to use spraying and dusting when there are only a few worms found in the plantation. It is advisable to stop applying the poison about 12-15 days before the leaves are to be harvested. The object of this is to let all the poison remaining on the surfaces of the leaves drop or wash away, so that there would be no question as to the leaves sprayed. It is was observed that when the plants are topped the leaves get harder and consequently the worms, if there be any, have greater difficulty in eating.

The approximate expense per hectare in spraying amounts to ₱34.00 while in powder only ₱13.35, showing ₱20.65 or 60 per cent in favor of the latter. In hand-picking as will be shown later, the expense is ₱40.00, or 54 per cent higher than spraying.

CONTROL BY FOWLS

The general practice among farmers is not to allow animals in their fields or gardens. This practice is wise in the case of farm animals, such as cattle, carabao, and hogs, etc.; but in the case of fowls, there would be little objection to their running in the fields and they help materially in controlling worms that attack farm crops.

In the college, observations were made to see whether or not chickens would control the tobacco cut-worms. Tobacco seedlings that were badly infested with cut-worms while in the seed-bed were transplanted to a piece of ground in the poultry yard. The result was that fowls picked the cut-worms but as the number of plants was much fewer than the number of fowls, the plants were almost all destroyed. However, it was concluded that it would be beneficial to allow fowls the free run of a plantation if there were many plants and few fowls—*they are not so confined in a limited area as the poultry-yard.*

One way of catching adult moths is by using the ripe fruit of guayabano, *Anona muricata.* Divide the ripe fruits into small pieces and spread them on boards, then place these boards in various parts of the field. It is a good scheme to start the experiment before six o'clock in the evening so as to be ready when the moths fly. The moths are attracted during the night by the smell of the fruit and they rest on the boards to suck the juice. While they are feeding, the traps must be visited with a lantern and the moths caught and killed. The deposition of an immense number of eggs is thus prevented. Besides the tobacco moths, many other insects can be caught, such as cockroaches, crickets, and other moths that are liable to be injurious to other field crops. Moths are observed to fly in the greatest numbers between 6:30 to 7:30 p. m.

NATURAL ENEMIES.

1. *Urogaster.*—A small parasitic hymenopteron was recorded on 23 February 1917 laying eggs in the larva of *Plusia* eriosoma. This parasite is a species of *Urogaster* and belongs to the family Braconidae, subfamily Micrograsterinae. The life history of this parasite is very interesting. The adult deposits eggs in the body of the larva by means of its ovipositor. The eggs hatch inside and the parasitic larvae develop there. When the larvae of the parasite reach their full size, they come outside to pupate, and the moth larva dies.

The full-grown larva is yellowish. Body flat; length 2-½ mm.; width 1 mm.; head large, broader than the body. Segments, 9 in number, segmental lines

very light and broken or discontinuous. One larva of *Plusia eriosoma* was found to harbor 19 parasitic larvae. The cocoon is made up of silky white threads; it is ellipsoidal, slightly rounded on both ends; length3 mm., diameter ½ mm.

2. *Microplitis manilae.* Mr. A. C. Toquero reported that *Microplitis manilae* was observed to be parasitic to the larva of *Chloridea assulta.* This parasite is a near relative of *Urogaster* and its life history is similar. The cocoon of the pupa is brown.

Charles R. Jones, formerly Entomologist of the Bureau of Agriculture, observes that a large Tachinid fly has been found to be parasitic on *Prodenia* particularly. Also, he says that a large black mud-dauber wasp was several times observed carrying off the larvae. He says further that birds also are important in the natural control of the pest, but to what extent has not been definitely determined.

3. Parasitic fungus.—On the 7th February, 1917 larvae of *Plusia eriosoma,* in large numbers, were found dead apparently from the attack of a parasitic fungus. This fungus belongs to the family Hyprocreceae; tribe Cavicipiteae; Genus *Cordyceps.* Besides being observed on *Plusia* it also attacked the pupa of *Prodenia* and undoubtedly the larvae also. Experiments have been made by applying spores in the form of dust made and wet. The first did not work at all while spores when slightly moistened with water showed a little effect on young larvae. These results indicate that *Cordyceps* works only at certain times of the year and under certain special conditions which favor its growth.

PREDACEOUS INSECT

Euagoras plagiatus Burm. is a hemipterous insect belonging to the family Reduviidae. It is predaceous on tobacco cut-worms. Instances have been frequently noted of this insect sucking the larvae of *Prodenia* and *Chloridea* in the field. It inserts its proboscis into the body of the worm and extracts the juices until the larva is dead. Observations of this in the field were mostly confined to the 1st, 2nd and 3rd larval stages. The following table gives some few instances.

Date of Observation	Kinds and number of larvae attacked	
	Prodenia	Chloridea
13-I-1917		2
23-I-1917		4
29-I-1917	1	
15-II-1917	2	6
5-III-1917	1	

This would seem to show that *Euagoras plagiatus* is distinctly a beneficial insect and the attention of the planters should be called to the fact that the killing of this insect might be avoided. In fact, it might be a good plan for growers to collect as many individuals as they could find elsewhere and scatter them in their plantations.

Description of the adult *Euagoras plagiatus* from the Fauna of British India, Rhynchota (1904) 2: 363.

"Head, pronotum, and scutellum reddish-ochraceous; a broad central longitudinal spot to posterior pronotal lobe, the hemelytra, and sternum black; lateral margins of hemelytra, lateral margins of sternum, abdomen beneath and legs very pale luteous; femora linearly streaked with black and with a subapical black annulation; abdomen beneath with a broad black fascia on each lateral area; acetabula luteous; coxae reddish-ochraceous; antennae fuscous, broadly annulated with ochraceous; rostrum luteous, its apex black; posterior spines to pronotum curved and reflexed; first joint of antennae as long as anterior femora, or as the head, pronotum, and scutellum together; body above finely grayishly sericeous.

Length 13-14 millimeters.

Habitat: Assam; East Garo Hills (Chemell) Bor Ghat (Dixon), Burma; Palon, Bhamo, Karennes (Fea). Tennesserim; Thaungying (Bingham), Meetam (Fea) Andamans:

BIBLIOGRAPHY

Burm. (*Zelus,* Nov. Act. Ac. Nat. Cur. XVI, Suppl. (1834), i. 303; Stál, Ent. Zeit. Stett. (1861); 22:136 id. En. Hem. iV, p. 24 (1874).

Darbanus nigrolineatus, Amy & Serv., Hemp. (1843), 371."

HAND-PICKING OF TOBACCO-WORMS

Hand-picking of tobacco-worms is objected to by many, as it is an expensive method. This is true when labor is high, but in places, like the Philippines, where labor is cheap, hand-picking of worms should not cost much. The approximate expense for one hectare for hand-picking from the time the plants are transplanted to harvest, amounts to ₱74.00, assuming that the worms are numerous and continue to be abundant. This estimate is for four boys employed five hours daily at the rate of six pesos (₱6.00) per month. The figure appears rather high but if the plants are properly handled the first half of the crop period, there will not be much trouble in the last half; so that the expense per hectare instead of being ₱74.00, need amount to only ₱37.00. Even the larger sum will be far more than recovered in the resulting better condition of the crop.

A. C. Morgan[1] says that when tobacco worms are numerous hand-picking will require an outlay of at least $8.00 to $10.00 an acre and frequently it will exceed $10.00. According to this the average per acre will be $9.00 or ₱39.60 per hectare. In the Cagayan Valley one family commonly handles about one hectare of tobacco and the average number of children in one family should be able to easily do all the worm picking.

SUMMARY OF RECOMMENDATIONS

1. Proper and thorough cultivation of the land before and after planting is an important factor in insect control. The advantage of plowing is that it destroys large numbers of *Prodenia* and *Chloridea* that spend part of their lives in the soil. Plowing brings the pupaei to the surface or else buries them deeper and in the former case they are killed by parasitic insects, by parasitic fungi, by exposure to the heat of the sun, or by birds. In the latter case they are prevented from emerging.

2. Clean culture is indispensable in insect control. By clean culture is meant not allowing the growth in and around the fields of weeds that furnish a food supply and hibernating places for the pests.

3. The removal of decaying leaves on the tobacco plants and removal of sprouts or dying plants should be practiced continuously. All these should be entirely destroyed.

4. The seedlings should not be kept too long in the seedbeds. They should be transplanted at the right age, for if they be so kept they are very likely to be attacked by stem borer.

5. When the worms are very serious the use of Paris green or tobacco dust whether in wet or dry form, is profitable, if properly prepared and applied.

6. Hand-picking is recommended when the pests are not unusually serious.

7. The natural enemies of tobacco worms should be known and protected.

8. The introduction in large numbers of predaceous insects, such as *Euagoras plagiatus*, would be profitable to the grower.

ACKNOWLEDGEMENTS

I desire to express my thanks to Professor C. F. Baker, Chief of the Department of Agronomy, under whose direction the foregoing work was done; to Professor Charles S. Banks, Chief of the Department of Entomology for identification of some of the insects; to Associate Professor O. A. Reinking for identifying the parasitic fungus; and to Mr. Leopoldo B. Uichanco, Assistant in Entomology, for suggestions relating to some phases of the work.

[1] U. S. Department of Agriculture, Bureau of Entomology, Circular No. 120.

COLLEGE NOTES

Preliminary work for the Experiment Station, funds for which have been provided by the last Legislature, has already been started. The survey of the land for this purpose is in progress.

Associate Professor Fred W. Ashton, of the Department of Chemistry, has been granted leave of absence with permission to visit the United States. He left Manila for San Francisco on March 15.

Private advices received from Mr. Segundo D. Labayen, '15, who obtained a Master's degree from the University of Louisiana last June, and who for sometime was assistant chemist in one of the sugar factories in New Orleans, state that he is now in Cuba as assistant chemist in the Alto Cedro Sugar Company at Marcaré, Oriente.

Private advices received from Mr. Nemesio Mendiola, '14, University Fellow in Plant Breeding at Cornell, say that he expects to finish his Ph. D. next Day.

Word has been received from the Bureau of Insular Affairs at Washington that Antonio P. Racelis, B. S. F., '15, sailed from San Francisco bound for the Philippines, on March 5. He will work in the Bureau of Forestry.

The students in the chemistry and agronomy of sugar cane paid a visit to the Calamba Sugar Estate last Saturday, March 23, for the purpose of studying the estate's methods of cultivating sugar cane and manufacturing sugar. They were taken into all the departments of the factory and shown the different steps in the modern manufacture of sugar. They were also taken into the field where they were shown a mechanical cane planter actually in operation. At noon they were served a splendid lunch. Through this column the members of the party desire to express their thanks to Messrs. Campion and Dumas and to the company as a whole for the kind reception they were given.

The School of Forestry held its commencement exercises on March 14. The following is the list of students who received the ranger's certificate:

Abarro, Domingo
Āmor, Roman
Arizabal, Gregorio
Baltazar, Alejandro
Cruz, Eugenio de la
Damo, Ambrosio
David, Aniano
Elumir, Gregorio
Flores, José
Fu, Huang Quang
Quevedo, Felipe
Reyes, Silvino
Rojas, Leon
Rondario, Maximo
Salvoza, Felipe
Soloria, Noberto
Tupas, Manuel
Valdez, Jose
Villanueva, Alberto
Zosa, Vicente